IQRA NATIONAL UNIVERSITY PESHAWAR

FANAL EXAM

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SUBJECT	**Water Demand Supply and Distribution**
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SEMESTER	**M.S(CIVIL ENGINEERING)**

QUESTION # 01

Define desalination and briefly describe various desalination methods? Which method is more effective, please elaborate briefly?

ANSWER # 01

Desalination:

Desalination is the process of removing salts and other minerals from the saline water to render it suitable for drinking, irrigation, or industrial uses.

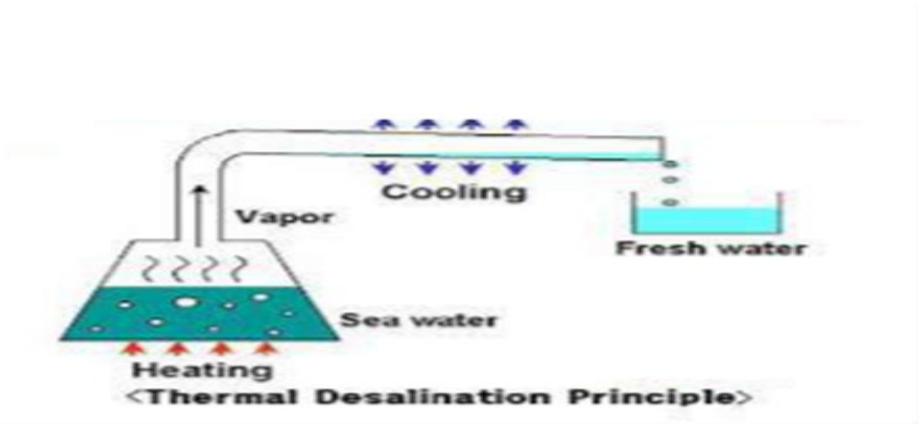
Various Desalination Methods are:

1. Distillation (Evaporation)
2. Electro dialysis
3. Freezing
4. Reverse osmosis

1. Distillation:

Distillation is the process of separating the components or substances from a liquid mixture by using selective boiling and condensation

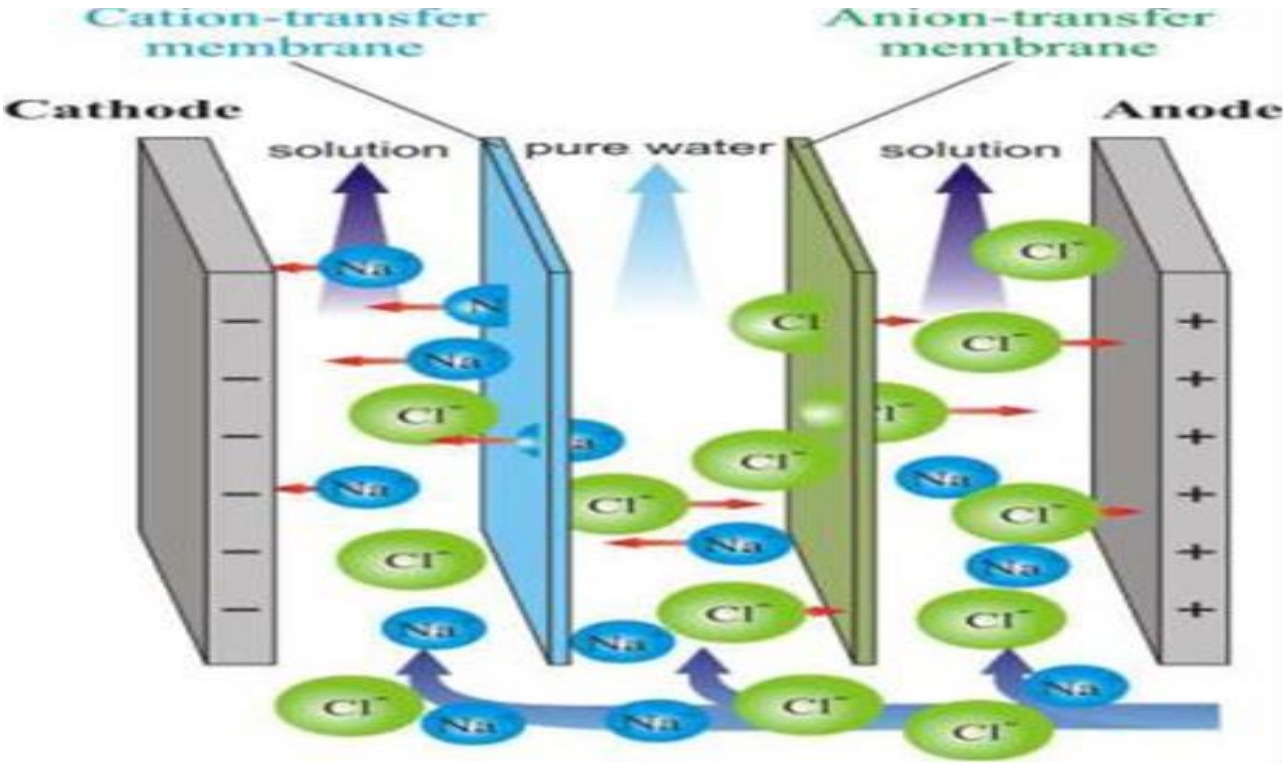
- Salt water is heated in one container to make the water evaporate, leaving the salt behind.
- The desalinated vapor is then condensed to form water in a separate container.
- Although long known, it has found limited applications in water supply because of the fuel costs involved in converting salt water to vapor is very high.



2. <u>Electrodialysis:</u>

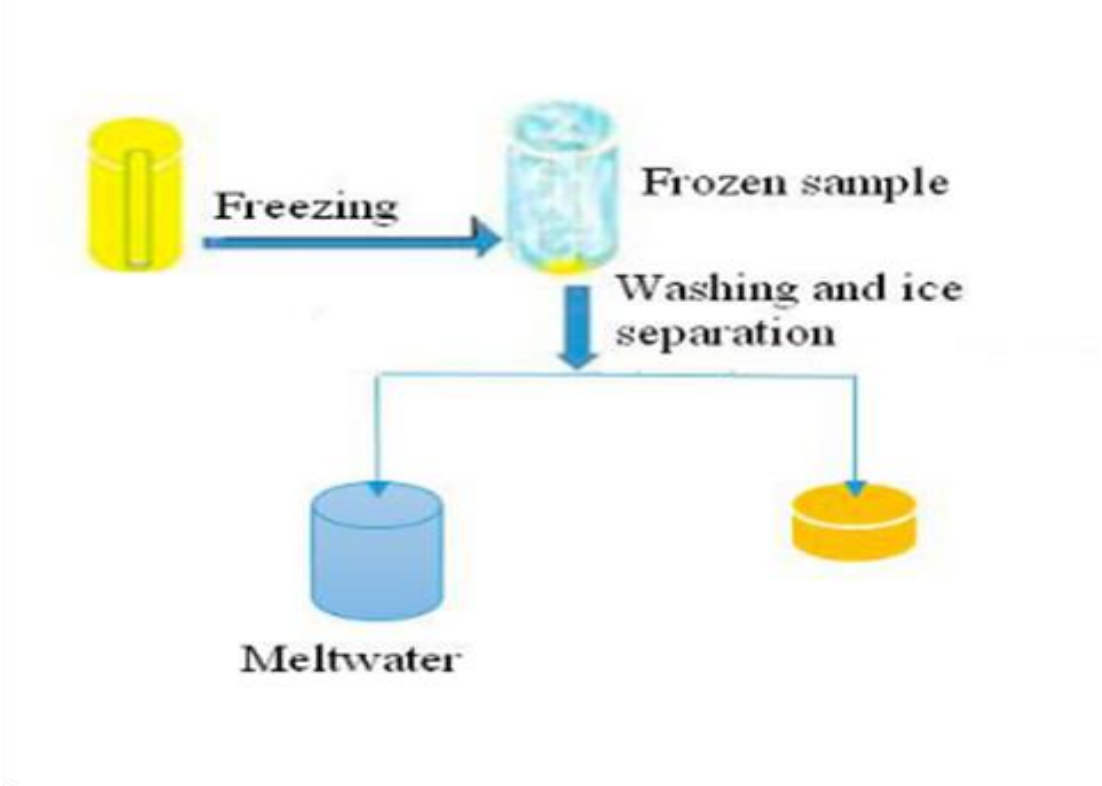
Electrodialysis is a process in which electrically charged membranes are used to separate ions from aqueous solutions under the driving force of an electrical potential difference.

- Electrodialysis utilizes a membrane, and sends an electric charge through the solution
- It draws metal ions to the positive plate on one side, and other ions (like salt) to the negative plate on the other side.



3. <u>Freezing Method:</u>

- It is based on the principle that water excludes salts when it crystallizes to ice.
- It involves three steps: Ice formation, ice washing, and ice melting to obtain fresh water with subsequent removal of contaminants



4.<u>Reverse Osmosis</u>:

- Reverse osmosis (RO) is a water purification technology / method that uses a semi-permeable membrane to remove ions, molecules, and larger particles from saline water.
- Reverse osmosis can remove many types of dissolved and suspended species from water, including bacteria, and is used in both industrial processes and the production of potable water.
- It significantly decreases the salts and other potential impurities in the water, resulting in a high quality and great-tasting water.

Steps Involved in Reverse Osmosis

<u>1st Step:</u>

➢ Removal of sediments from the water. In this step all the sediments like clay, silt and stones are removed from the water.

➢ For this, a 5-micron filter is used. The sediments are filtered in order to make sure that no damage is done to the membrane.

➢ The micron filter does not let these particles pass by and thus they are suspended.

2nd Step:

- In the second step carbon filter is used to remove the chlorine and other harmful chemicals that enter the water sources.
- These chemicals are harmful to human health and thus it is necessary to remove them.

3rd Step:

The third step focuses on passing the water from a dense and compacted carbon filter. Most of the contaminants are removed here.

4th Step:

- Water passes through the membrane and all the heavy metals present in the water are removed.
- Along with the metals, radioactive metals too are removed. In this step, the impurities are drained out of the reverse osmosis system and clean water is separated.

5th Step:

- In this last stage, the bacteria, chlorine, and bad odour are removed from water. After water passes from this stage, it comes out of the faucet and is perfect for consumption.
- This step involves tertiary treatment or polishing.

Desalination is process primarily done in developed countries with enough money and resources.

If technology continues to produce new methods and better solutions to the issues that exist today, there would be a whole new water resource for more and more countries that are facing drought, competition for water, and overpopulation.

Which method is more effective:

Reverse osmosis is an effective means to desalinate saline water, but it is more expensive than other methods. As prices come down in the future the use of reverse osmosis plants to desalinate large amounts of saline water should become more common.

QUESTION # 02:

Briefly describe merits and demerits of 4 types of water distribution layouts? Which layout will you recommend for newly proposed township in hilly area? Support your answer with justification?

ANSWER # 02:

There are four principal methods to design a distribution system:

1. Dead end or tree system
2. Gridiron system
3. Circular or ring system
4. Radial system

Merits and Demerits of Water Distribution Layouts:

1. **Dead End system:**

Advantages:

- The design calculation is simple and easy.
- A smaller number of cut-off valves are required and the operation and maintenance cost is low.
- Pipe laying is simple
- They are relatively cheap.
- Due to a smaller number of valves determination of discharges and pressure is easier.

Disadvantages:

- The system is less successful in maintaining satisfactory pressure in remote areas and is therefore not favored in modern waterworks practice
- One main pipeline provides the entire city, which is quite risky
- Stagnation of water in pipes occur due to many dead ends.
- The discharge available for firefighting in the streets is limited due to high head loss in areas with weak pressure.

2. Radial System:

Advantages:

- Simplest as fed at only one end.
- The initial cost is low.
- It is useful when the generating is at low voltage.
- Preferred when the station is located at the center of the load.
- More economical for some areas which have a low load requirement

- Require less amount of cables
- It has a low maintenance
- It gives quick service and there is no stagnation.
- This system of layout ensures high pressure in distribution and it gives quick and efficient water distribution.

Disadvantages:

- The end of distributor near to the substation gets heavily loaded.
- When load on the distributor changes, the clients at the distant end of the distributor face serious voltage fluctuations.
- As users are dependent on single feeder and distributor, a fault on any of these two causes interruption in supply to all the users connected to that distributor
- It may, however, be stated that generally only any one of these four systems of layout may not be suitable for the entire city or town.

3. <u>Grid Iron System</u>:

Advantages:

- The free circulation of water, without any stagnation or sediment deposit, minimizes the chances of pollution due to stagnation.
- Enough water is available at street fire hydrants, as the hydrant draws water from the various branch lines.
- During repairs, only a small area of distribution is affected.
- Since the water in the supply system is free to flow in more than one direction, stagnation does not occur as readily as in the branching system.
- In case of repair or break down in a pipe, the area connected to that pipe will receive the water, as water will flow to that area from the other side.
- Water reaches all points with minimum head losses. At the time of fires, by manipulating the cut off valves, plenty of water supply may be diverted and concentrated for firefighting.

Disadvantages:

- A large number of cut-off valves are required.
- The system requires longer pipe lengths with larger diameters.
- The analysis of discharge, pressure and velocities in the pipes is difficult and cumbersome.
- The cost of pipe laying is higher.

4. Ring or Circular System:

Advantages:

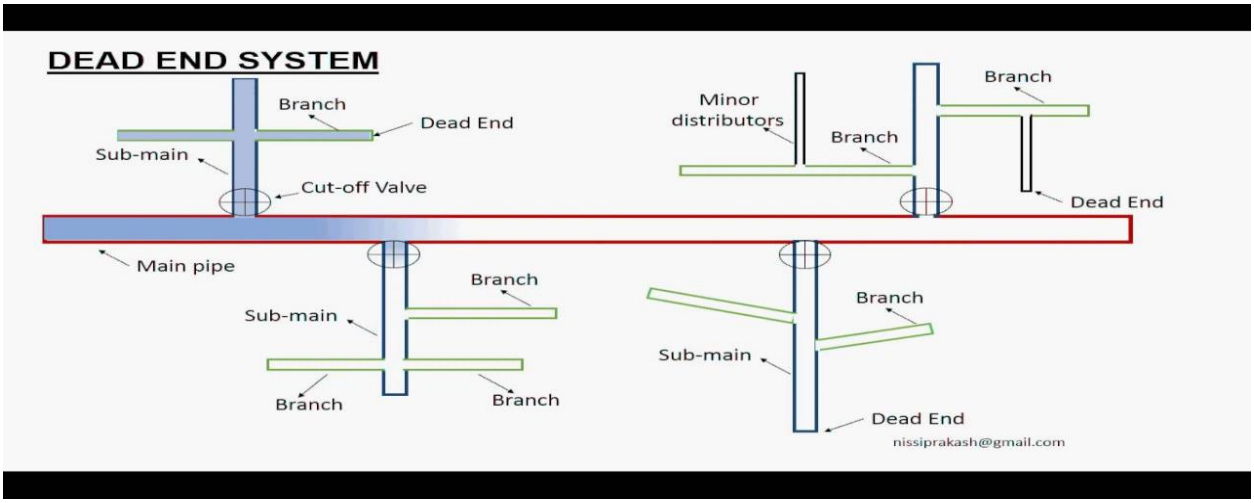
- In ring power is supplied from both ends as compared to radial
- In case of a fault in the radial circuit the entire system goes off unlike in ring where by incase one end gets a fault the other end still keeps on supplying power
- Compared to the radial system, the voltage drop is less along the distribution line
- More subscribers can be installed to the system than the radial system
- Less voltage fluctuations can be seen at client's terminals. Voltage fluctuations in high loaded areas can be reduced using a tie line
- Determination of pipe sizes is easy. Water can be supplied to any point from at least two directions. The advantages and disadvantages of the ring system is same as grid iron system.

Disadvantages:

- Ring is very expensive n requires more materials.
- Radial circuit is more economical.
- High maintenance cost.
- It is not usable when the client is located at the center of the load

Type of layout used in newly proposed township in hilly area:

In hilly areas, mostly the areas are unplanned. So, we will recommend the dead-end system are to be used in hilly area as shown in the following figure.



QUESTION # 03:
What are different types of reservoirs used in water supply systems? Briefly describe its importance and how its storage capacity be calculated?

ANSWER # 03:

Distribution reservoirs, also called service reservoirs, are the storage reservoirs, which store the treated water for supplying water during emergencies (such as during fires, repairs, etc.) and also to help in absorbing the hourly fluctuations in the normal water demand

Types of Reservoirs:

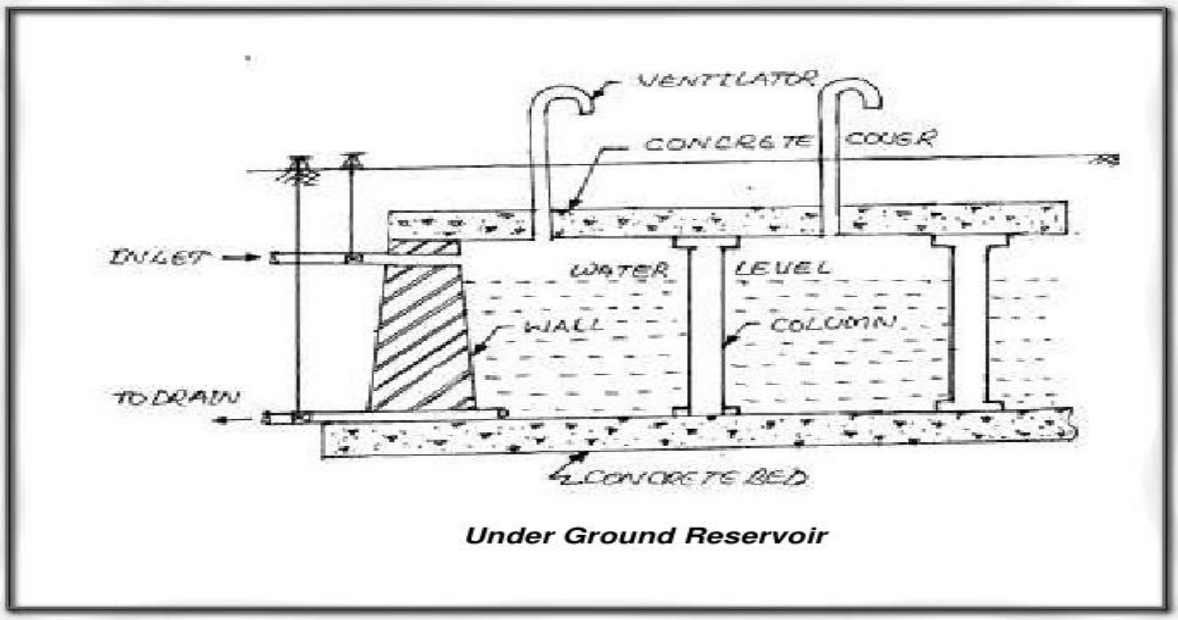
Depending upon their elevation w.r.t ground it may be classified into:

1. Surface reservoirs
2. Elevated reservoirs

1. Surface reservoirs:

Surface reservoirs are built structures for water storage that help improve water security for local communities. The types and sizes of reservoirs vary, from damming natural water bodies for storage to ground excavation in low-lying plains fed either by rainwater or diverted rivers. These are also called ground reservoir.

- Mostly circular or rectangular tank.
- Underground reservoirs are preferred especially when the size is large.
- In case of gravity system, underground reservoirs are generally constructed on high natural grounds and are usually made of stones, bricks, plain or reinforced cement concrete.
- The side walls are designed to take up the pressure of the water, when the reservoir is full and the earth pressure when it is empty.
- The position of ground water table is also considered while designing these reservoirs.
- The floors of these reservoirs may be constructed with R.C.C slab or stone blocks with sufficient water proofing.
- To obtain water tightness bitumen compounds are used at all construction joints.
- For aeration of water and inspection, manholes, ventilation pipes and stairs are provided.

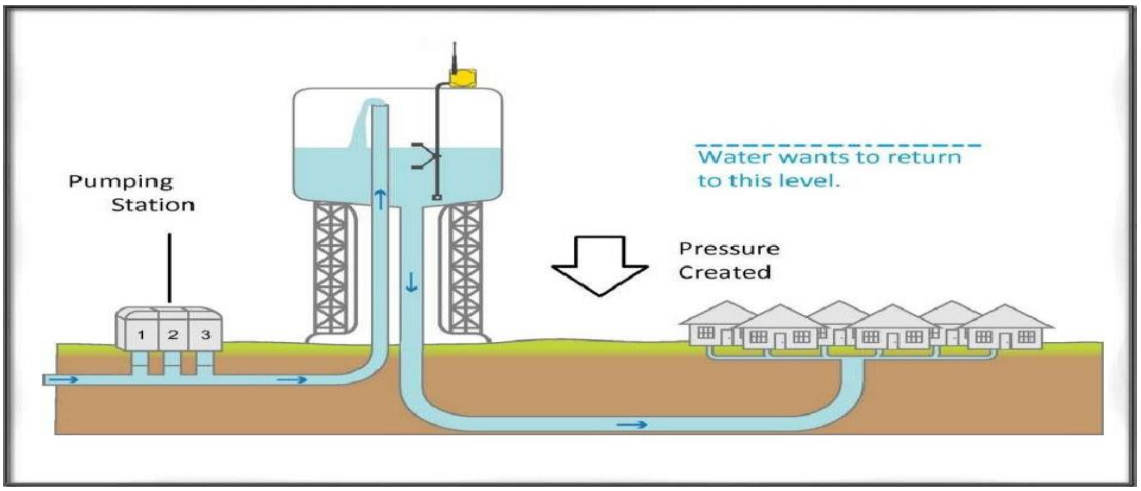


Under Ground Reservoir

2. <u>Elevated Storage Reservoirs:</u>

Elevated Storage Reservoirs also referred to as Overhead Tanks are required at distribution areas which are not governed and controlled by the gravity system of distribution.

- Elevated Storage Reservoirs also referred to as Overhead Tanks are required at distribution areas which are not governed and controlled by the gravity system of distribution.
- These are rectangular or circular in shape.
- If the topography of the town is not suitable for gravity system, the elevated tank or reservoir are used to provide sufficient pressure head.
- They are constructed where combine gravity and pumping system of water distribution is adopted.



Importance of reservoirs used in water supply systems:

Under these conditions, more water is released from the reservoir so farmers can water their crops and homes and businesses can function normally. Reservoirs serve other purposes. They are used for boating, fishing, and other forms of recreation. Some of the dams that create reservoirs are used to generate electricity.

Storage Capacity Reservoirs:

The total storage capacity of a distribution reservoir is the summation of:

1. **Balancing Storage:**

   The quantity of water required to be stored in the reservoir for equalizing or balancing fluctuating demand against constant supply is known as the balancing storage (or equalizing or operating storage).

2. **Breakdown Storage**:
   - The breakdown storage or often called emergency storage is the storage preserved in order to tide over the emergencies posed by the failure of pumps, electricity, or any other mechanism driving the pumps.
   - A value of about 25% of the total storage capacity of reservoirs, or 1.5 to 2 times of the average hourly supply, may be considered as enough provision for accounting this storage.

3. **Fire Storage:**
   - The third component of the total reservoir storage is the fire storage.
   - This provision takes care of the requirements of water for extinguishing fires.
   - Fire demand maybe calculated by the given formulas:
   - The total reservoir storage can finally be worked out by adding all the three storages.

$$Q_F = 65\sqrt{P}(1-0.01\sqrt{P})$$

Q_F = fire demand l/s
P = population in thousands

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P = population in thousands

$$Q_F = 320 * C\sqrt{A}$$

Q_F = fire demand flow m^3/d
A = areas of all stories of the building under consideration (m^2)
C = constant depending on the type of construction;

QUESTION # 04:
Why pumps are used in water supply schemes and how to calculate pump curve to meet water demand?

ANSWER # 04:

During the late night and very early morning hours, when water demand is lower, high-lift pumps fill the tank. During the day, when water demand is higher, water flows out of the tank to help satisfy the peak hourly water needs. This allows for a uniform flow rate at the treatment plant and pumping station.
Pumps that increase the pressure within the distribution system or raise water into an elevated storage tank are called booster pumps. Well pumps lift water from underground and discharge it directly into a distribution system. The flow rate through a centrifugal pump depends on the pressure against which it operates.

Pump curve:
Curves typically include performance metrics based on pressure, flow, horsepower, impeller trim, and Net Positive Suction Head Required.

Pump curves are useful because they show pump performance metrics based on head (pressure) produced by the pump and water-flow through the pump. Flow rates depend on pump speed, impeller diameter, and head.

Pumping systems are generally designed for:

1. Head: Sum of kinetic and potential energy of liquid expressed in unit of length (meters / feet)
2. Flow / Discharge: Quantity of water pumped per unit time. It is expressed in gallons / day, Liters / minute etc.
3. Pressure: The flowing liquid / water should have sufficient pressure at the destination and is normally expressed in pounds per square inch (psi)

The Formula for PSI:

Pressure (PSI) * 2.31 / specific gravity = Head (feet)

Flow is the volume of water a pump can move at a given pressure. Flow is indicated on the horizontal axis in units like gallons per minute, or gallons per hour, as shown in Figure 2.

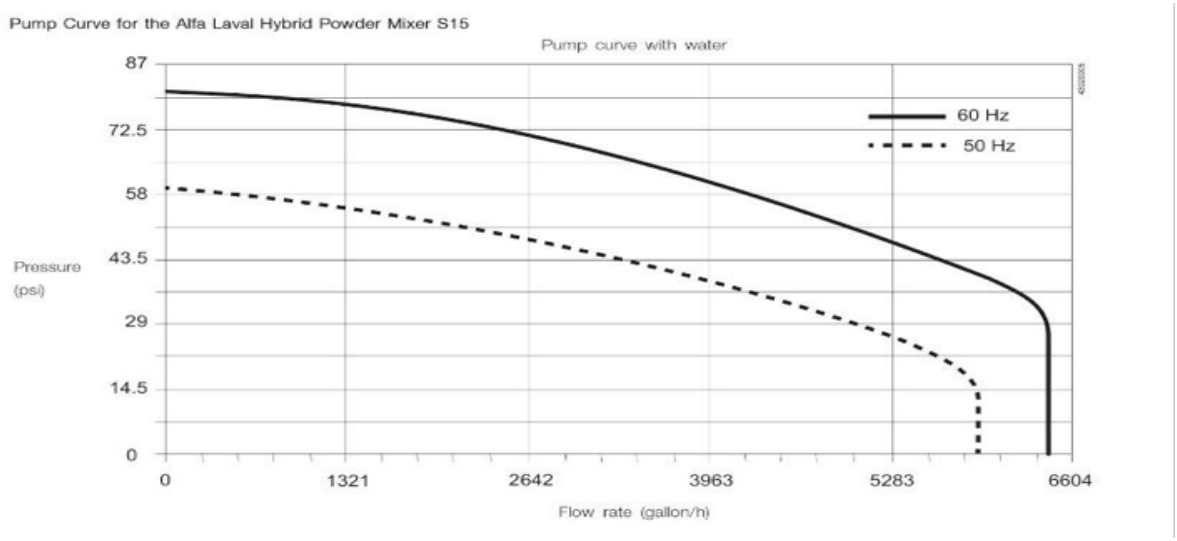

Fig. 2. A basic pump curve shows a pump's performance range. In this curve, head is measured in PSI; flow is measured in gallons per hour.